New evidence for a depleted Hawaiian Plume component in Cretaceous Emperor Seamounts

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Depleted (MORB-like) geochemical compositions have been found at the Meiji and Detroit Seamounts, oldest in situ products of the Hawaiian Hotspot, located at the northwestern end of the Cretaceous Emperor Seamount chain. The origin of these depleted compositions is controversial. It has been proposed that the depleted component was derived either through melting of depleted (MORB source) upper mantle interacting with the Hawaiian plume near a spreading center (Keller et al. 2000, Nature 405), or through melting of a depleted component in the plume sampled due to enhanced melting beneath thin lithosphere (Huang et al. 2005, G-cubed 6: Q01L06; Regelous et al. 2003, J. Petrol. 44). During two of the R/V SONNE 201 cruises, relatively fresh shield stage tholeiites were recovered from the NW Emperor seamounts (Suizei, Tenji and Meiji). New major and trace element and isotope (Sr, Nd, Pb) investigations of whole rocks and major and trace element compositions of olivine phenocrysts provide new insights into the origin and evolution of the Hawaiian plume volcanism in the Late Cretaceous. The recovered samples range from enriched tholeiites on Meiji and Tenji Seamounts with high La/Yb (1.5 to 6.5) to depleted tholeiites at Suizei Seamount with low La/Yb (0.7 to 1.2), nearly indistinguishable from MORB tholeiites. Initial Pb and Nd isotope ratios from the seamount samples form a very tight inverse linear array, consistent with mixing of two mantle components. The enriched endmember, represented by a sample from Meiji, has, e.g., high initial 206Pb/204Pb (18.7), unradiogenic Nd (0.51295) and high La/Yb (6.5) and is similar to the Kea component in present day Hawaiian tholeiites (Abouchami et al., 2000, Chem. Geol. 169) and has also been found in Early to Mid-Cretaceous Hawaiian plume-related rocks in Kamchatka (Portnyagin et al., 2008, Geology 36). The more depleted endmember, represented by a sample from Suizei, has, e.g., low initial 206Pb/204Pb (17.6), radiogenic Nd (0.51302) and low La/Yb (0.7). An extension of the mixing array to less radiogenic Pb, however, does not intersect the Pacific MORB field (Nd isotope ratios in MORB being higher at a given Pb isotope ratio). Trace elements in olivine suggest that the melts were derived from mantle peridotite with only a minor addition of eclogite. Therefore, we believe that the Suizei endmember was a component in the Hawaiian plume: either a depleted component, e.g., recycled oceanic lithospheric mantle, (Regelous et al. 2003; Huang et al. 2005; Portnyagin et al., 2009, EPSL 287) or possibly ancient primitive mantle (Jackson et al., 2010, Nature 466; Jackson and Carlson, 2011, Nature 476). In conclusion, the new data from the NW Emperor Seamounts confirm the presence of both an enriched Kea type and a depleted or primitive mantle component in the Late Cretaceous Hawaiian plume.